DEPARTMENT OF MECHANICAL AND MATERIALS ENGINEERING
COLLEGE OF ENGINEERING AND APPLIED SCIENCE

SUMMER RESEARCH OPPORTUNITIES FOR UNDERGRADUATE WOMEN

FOR APPLICATION YEAR: 2021

PROJECT TITLE: **Thermoelectrics with Large Magnetic Fields**

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Project Description

The majority of the worldâ€™s energy sources are currently non-renewable. Additionally, most energy generation processes reject waste-heat as a result of typical energy conversion inefficiencies. If this waste-heat could be recovered and harnessed, the efficiency of the worldâ€™s current energy sources would greatly increase. Solid-state materials called thermoelectric materials can do this. In conventional thermoelectric energy conversion, heat is converted into electricity. When a material is placed between a heat source (potentially from waste-heat) and a heat sink, a temperature differential exists. This temperature differential drives charge carrier (electrons and holes) movement, which induces an electrical current that could be used as an output voltage. Traditional thermoelectric materials are semiconductors, where n-type and p-type couples are connected electrically in series and thermally in parallel. Here, the applied temperature differential and output voltage are parallel to one another. Current thermoelectric materials, though, are not yet efficient enough to warrant their usage in waste-heat recovery beyond niche applications.

The goal of this project is to utilize novel thermal-to-electrical energy conversion mechanisms present in unconventional thermoelectric materials with the help of a magnetic field. The project specifically considers topological Weyl semimetals, a new material first experimentally-realized in 2015. Weyl semimetals have shown unprecedentedly large thermal-to-electrical energy conversion when the temperature differential and output voltage are perpendicular, not parallel, to one another. This specific case, though, requires large externally applied magnetic fields. The WISE student for this project will be working to gain a fundamental understanding of coupled thermal, electrical, and magnetic transport in Weyl semimetals by manipulating the size of the applied magnetic field and the geometrical relation between thermal, electrical, and magnetic gradients in order to maximize thermal-to-electrical energy conversion. This project will be completely experimental, with the student preparing samples for measurements in the lab, designing appropriate experiments, and executing the transport measurements on the characterization system in the lab.